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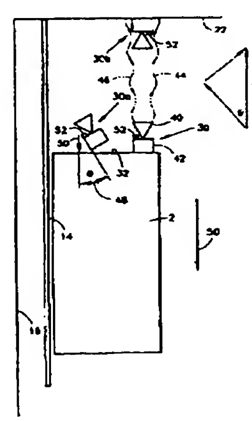
[54]发明名称 电梯轿厢速度的检测装置和方法

[57]摘要

本发明涉及电梯轿厢速度的检测设备和方法。设有一雷达速度传感器(30)来确定电梯轿厢(2)的速度。速度传感器产生一信号，由处理器(52)处理并经由速度检测模块(70)与速度阈值比较。速度检测模块产生一超速信号(72)触发致动器(34)和安全制动器(26)动作。



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权 利 要 求 书

1. 一种电梯速度检测系统，包括：

一种检测电梯轿厢速度和产生一速度信号的速度传感器系统；和

一比较产生的对应于电梯轿厢速度的输出信号的速度检测模块。

2. 如权利要求1的电梯速度检测系统，其中，该速度传感器系统包括：

一定向发送信号的发送器；

一接收返回信号的接收器；和

一从接收器接收返回信号并产生一速度信号的处理器。

3. 如权利要求2的电梯速度检测系统，其中，发送器和接收器包括一雷达装置，还包括一天线。

4. 如权利要求2的电梯速度检测系统，其中，处理器包括一滤波器，一限幅器和一频率－电压变换器或一锁相环路。

5. 如权利要求2的电梯速度检测系统，其中，处理器包括一滤波器、一模拟－数字转换器和一数字信号处理器。

6. 如权利要求2的电梯速度检测系统，其中，发送器和接收器安装在井道内电梯轿厢的顶部或底部。

7. 如权利要求6的电梯速度检测系统，其中，井道包括壁和导轨，发送的信号指向壁或导轨。

8. 如权利要求6的电梯速度检测系统，其中，还包括一安置在壁或导轨上的均匀结构，发送的信号指向上述均匀的结构。

9. 如权利要求6的电梯速度检测系统，其中，井道包括一天花板和一底部，发送的信号指向天花板或底部。

10. 如权利要求2的电梯速度检测系统，其中，电梯轿厢安置在井道内，发送器和接收机安装在井道内，发送的信号指向电梯轿厢。

11. 如权利要求2的电梯速度检测系统，其中，还包括速度检测模块，将速度信号与一速度阈值比较并产生一对应于超速状态的超速信号。

12. 一种电梯系统，具有一电梯轿厢和一安全制动系统，该电梯系统包括：

一检测电梯轿厢速度和产生一速度信号的速度传感器系统；

一将速度信号与一速度阈值比较并产生一对应于超速状态的超速信号的速度检测模块;

一接收超速信号并触发安全制动系统的致动器.

13. 如权利要求12的电梯系统，其中，速度传感器系统包括:

一定向发送信号的发送器;

一接收返回信号的接收器; 和

一接收从接收器的返回信号并产生一超速信号的处理器.

14. 如权利要求13的电梯系统，其中，发送器和接收器包括一雷达装置和还包括一天线.

15. 如权利要求13的电梯系统，其中，处理器包括: 一滤波器; 一限幅器; 和一频率-电压变换器或一锁相环路.

16. 如权利要求13的电梯系统，其中，处理器包括: 一滤波器; 一模拟-数字转换器; 和一数字信号处理器.

17. 如权利要求13的电梯系统，其中，发送器和接收器安装在井道内的电梯轿厢的顶部或底部.

18. 如权利要求17的电梯系统，其中，井道包括壁和导轨，发送的信号指向壁或导轨.

19. 如权利要求18的电梯系统，其中，还包括安置在壁或导轨中的均匀的结构，发送信号指向均匀的结构.

20. 如权利要求17的电梯系统，其中，井道包括一天花板和底部，发送的信号指向天花板或底部.

21. 如权利要求13的电梯系统，其中，电梯轿厢安置在井道内，发送器和接收器安装在井道内，发送的信号指向电梯轿厢.

22. 一种检测电梯轿厢的超速状态的方法，包括:

检测电梯轿厢的速度;

产生一速度信号;

比较速度信号与速度阈值;

产生一超速信号.

23. 如权利要求22的检测方法，其中，电梯轿厢具有顶部和底部并安置在一具有天花板、底部、壁和导轨的井道内，上述的检测包括:

将发送的信号指向天花板、底部、壁、导轨、顶部或底部; 和

接收返回信号.

说　　明　　书

电梯轿厢速度的检测装置和方法

本发明涉及一种电梯速度的检测和监视装置和方法．更具体地说，本发明涉及一种用来检测电梯轿厢的超速状态并提供一相应的电信号的装置和方法．

目前，电梯设有多个制动装置，它们被设计用于在电梯的正常运行中，例如使电梯保持在它在平台的停靠处，并被设计成用在紧急状态，例如止动电梯轿厢的自由下落运动．

设置一个这种制动装置用来使超过预定速率运行的超速电梯轿厢慢下来．这种制动装置一般应用一触发安全装置运作的调速装置．在这种电梯系统中设有一调速绳索，它绕过井道顶部的滑轮和井道底部的拉紧轮，并固定在电梯轿厢上．当调速绳索超过电梯轿厢的预定速率时，调速装置抓紧调速绳索，拉紧与轿厢连接的两根杆．这两根杆拉动楔形安全器，后者夹紧上面运行着电梯轿厢的导轨，从而制动和使电梯轿厢减慢．

用来检测电梯轿厢超速的装置和方法对于安全制动系统的正确工作很重要．在传统的系统中，电梯轿厢的超速可通过调速绳索、调速轮、拉紧轮或操作安全装置的机械连杆监测．例如，上述的调速轮应用一离心装置，当达到超速状态时，后者接合一制动器而在调速绳索上产生阻力，从而触发安全装置．调速绳索使调速轮按与电梯轿厢的直线速度相关联的旋转速度旋转．调速器具有离心配重，它随增加的速度向外运动，结果增加了离心力．当电梯超过预定速度时，离心配重拨动一超速开关，后者使一组爪抓住绳索并使安全器动作．在其它的系统中，将一转速表安装在固定在轮上的辅绳上并用来监测电梯轿厢的超速状态和使安全器动作．

现有系统的缺点是绳索和调速系统会出现磨损．这种磨损的最大问题是不能用肉眼检测．此外，当出现超速状态时，需要电梯不服务，直至一机构用来重新设置调速装置和释放安全器．

调速绳索组件的另一缺点是需要维修和需要井道空间．调速绳索、轮和连杆必须周期性地清洁、润滑和更换．所有维修要求对于本领域技术人员而言是烦人的，因而是不希望的性能．这样需要一种去

除调速绳索组件并需要监视和检测电梯轿厢超速状态的精确装置和方法，而不需要调速绳索组件．根据这一需要，还需要一检测电梯超速状态的精确的、非接触的、连续和瞬发的装置和方法．

因此，本发明的一个目的是提出一种检测电梯轿厢的超速状态的改进的方法和装置．

按照本发明，电梯的超速状态是利用一雷达速度传感器通过确定电梯的速度来检测的．速度传感器按精确的、非接触连接和瞬发的方式连续地监视电梯的速度和方向，而不使用现有技术的绳索调速系统．在本发明的实施例中，速度传感器安装在电梯轿厢上并将发送的信号指向井道的一部分或导轨．在另一实施例中，速度传感器安装在井道的天花板或底部并将发送的信号指向电梯轿厢．速度传感器接收返回信号并产生一表示电梯轿厢的速度和方向的速度信号．速度信号被一微处理器接收，后者将该速度信号与对应于超速状态的预定阈值比较．当存在超速状态时，微处理器产生一超速信号而能够使安全制动器减慢电梯．

根据下面对本发明的详细描述将更加明了本发明的上述的和其它的目的，特征和优点；附图所示为：

图 1 表示在井道中采用本发明传感器的电梯的局剖立体图；

图 2 表示采用本发明的速度传感器的电梯的示意侧视图；

图 3 表示按照本发明的速度传感器和处理器的示意图；

图 4 表示按照本发明的速度传感器和处理器的另一实施例的示意图；

图 5 表示按照本发明的速度传感器和处理器的又一实施例的示意图；

图 6 表示按照本发明的结构带片段的透视图．

图 1 表示一位于框架 4 上的本发明的电梯轿厢 2，该框架由绳索 6 悬挂并由其运动．电梯框架 4 包括一块安放电梯轿厢 2 的安全板 8、两个在轿厢框架 4 各侧的立柱 12 和一直接固定电梯绳索 6 的横梁 10．轿厢框架 4 的每一侧均有导轨 14，轿厢框架 4 在导轨 14 上在滚轮 16 内移动．电梯轿厢 2 在由壁部 18、底部 20 和天花板 22 所界定的井道内通过电机（未示出）而竖直移动．

本发明的电梯轿厢 2 不采用现有技术的调速器绳索组件来在超速

状态出现时触发安全制动系统。按照本发明，一雷达速度传感器 30 安装在电梯轿厢 2 的顶面 32 并向井道 17 的天花板 22 发射。如下文还要更全面解释的，雷达速度传感器 30 连续发出电磁信号，这些信号被天花板 22 反射。传感器 30 连续检测返回的信号。该传感器包括一无线电收发机，该收发机连同处理装置计算电梯轿厢 2 运行的速度和方向。当出现超速时，传感器 30 发出一输出信号，该信号最终被用来触发安全制动系统。在图 1 所示的实施例中，输出信号触发致动器 34 并通过位于电梯轿厢 2 每一侧的连杆系统 36、传递杆 38 而启动对导轨 14 施加制动力的安全制动器 26。致动器 34 可以包括一气缸、一液压缸、一电机、一电制动器或一可以变换连杆系统 36 的等效装置。速度传感器 30 在检测出轿厢 2 沿向上运行和朝下运行两个方向的超速状态时允许起动安全制动系统，为此，一组安全制动系统安装在电梯轿厢 2 的顶部，以便沿朝下方向止动轿厢，一组安全制动器 26 安装在轿厢底部，以便沿向上方向止动轿厢。

下面参见图 2 所示的本发明的三个不同的实施例。在第一实施例中，速度传感器 30 安装在电梯轿厢 2 的顶部，并由一雷达振荡收发机例如多普勒雷达或类似物组成，该收发机包括一天线 40 和一连接在其上的振荡接收机 42。如图所示，无线 40 是一喇叭型天线，但也可以包括一平面天线阵，或接线板、天线或者其它类型的天线。振荡接收机 42 可以包括一市售类型的振荡接收机例如，由 M/A 公司提供的与天线 40 连接的 MA 86849－M01 或 MA86843－M05 型。双通道振荡接收机的使用允许测量运行的电梯轿厢 2 的速度和方向，以便沿向上方向和向下方向作超速控制。虽然所示的速度传感器 30 是一整体式多普勒雷达装置，但它是作为例示而不是限制。当然，速度传感器 30 可以包括一独立的发送机、天线和接收机以及类似的装置，这些都属于本发明的范畴。此外，在本发明范围的还有，速度传感器 30 可以包括其它类型的雷达，例如由 Eaton 公司制造的 VORAD ETV－200 传感器、无反射雷达和转发机装置。

如上所述，速度传感器 30 是一雷达装置，它通过天线 40 不断发出由 44 表示的电磁信号。发送的信号 44 被天花板 22 反射，由 46 表示的返回信号被天线 40 接收。反射的信号 46 载有轿厢 2 相对于反射面（天花板 22）的速度的信息。

在图 2 所示的第二实施例中，速度传感器 30a 相对于用 50 表示的电梯轿厢 2 的速度矢量按用 48 表示的角度θ倾斜地安装在电梯轿厢 2 上。速度传感器 30a 被定位成朝导轨 14 或壁 18 连续发送磁信号并由它们反射。类似于速度传感器 30，速度传感器 30b 安装在天花板 22 上，朝电梯轿厢 2 不断发送磁信号并被其反射。此外，属于本发明范围的有，速度传感器 30 可以安装在电梯轿厢 2 的地板上，朝井道 17 的底部 20、导轨 14 或壁 18 不断发送磁信号并被其反射，此外，速度传感器 30 可以安装在井道 17 的底部 20 上，朝轿厢底部不断发送磁信号并被其反射。

一旦返回信号 46 被速度传感器 30 接收，振荡收发机 42 就输出一在图 3、4 和 5 中用 68 表示的速度信号 f_{out}，该信号包括按照下列公式与电梯轿厢 2 的速度 V_{ca} 成正比的频率：

$$f_{out} = COS(\theta)*2*V_{car}*f_{rad}/V_{Light}$$

其中：V_{Light}=光速 = 3×10^8 米/秒

f_{rad} = 辐射频率 = 24.125GHZ

θ = 传感器轴线和速度矢量之间的夹角 48.

上述公式简化为

$$f_{out} = 160.8*V_{ca}*COS(\theta)$$

速度传感器 30 和 30b 的角度θ为 0.0，该角度使得振荡收发机 42 的输出信号的换算系数等于 160.8HZ/(m/s). 速度传感器 30a 的换算系统取决于安装角 48 的值.

返回信号 46 含有一些认为是散射和噪音以及多普勒最大频率的不希望的频率，这些频率的平均值相应于电梯轿厢 2 的速度. 一些不希望的频率是当信号 44 从天线 40 按扩散（被称为视角）发射时，发射的信号 44 发散的结果产生的. 上述视角引起返回信号 46 中频率的相应发散. 已发送信号 44 中其它不希望的频率可能由安装的速度传感器 30 的振动或者由于障碍物中止了信号而引起，上述信号又转换成返回信 46 中的不希望的频率. 此外，一小部分发射的信号 44 在反射之前直接被天线 40 接收并与反射面（22，14 或 18）中的变量一起可引起噪音或返回信号 46 中的其它不希望的信号.

用 54 表示的振荡接收机 42 的输出信号（图 3，4，5）以返回信号 46 为基础并由连接有振荡接收机 42 的处理器 52 处理. 输出信号

54 由变宽的重叠频率的谱线组成，如上关于返回信号 46 所述. 在信号 54 的频率中有一直流偏压和一载有关于电梯轿厢 2 的速度以及噪音和其它不同频率的信息的交流电（AC）. 处理器 52 阻挡输出信号的直流部分并用来确定有关电梯轿厢 2 速度的输出信号 54 的平均频率. 本发明的一个变型实施例示于图 6 中，其中的结构条 27 设置在导轨 14 或壁 18 上并用来与速度传感器 30a(图 2)相结合. 结构条 27 包括一作为简单线条为例子示出的突起部 28 的均匀构造. 结构条 27 产生具有增加反向反射量的返回信号 46, 从而增加反射和提高本发明的工作精度. 结构条 27 可以用任何适当的方法固定在导轨 14 或壁 18 上. 在另一变型实施例中，突起部的均匀构造可以在导轨的制造过程中直接压印入导轨 14 或直接加工在壁 18 上.

现在参照图 3, 图中示出了一个适合于与速度传感器 30 一起使用的处理器的实施例. 处理器 52 由一消除高频噪音的低通滤波器 56 和一稳定输出信号 54 幅值的限幅器 58 组成. 输出信号 54 的频率使用市售的频率 - 电压变换器 60 例如由松下半导体公司提供的 LM2907 或 10LM2917 估算.

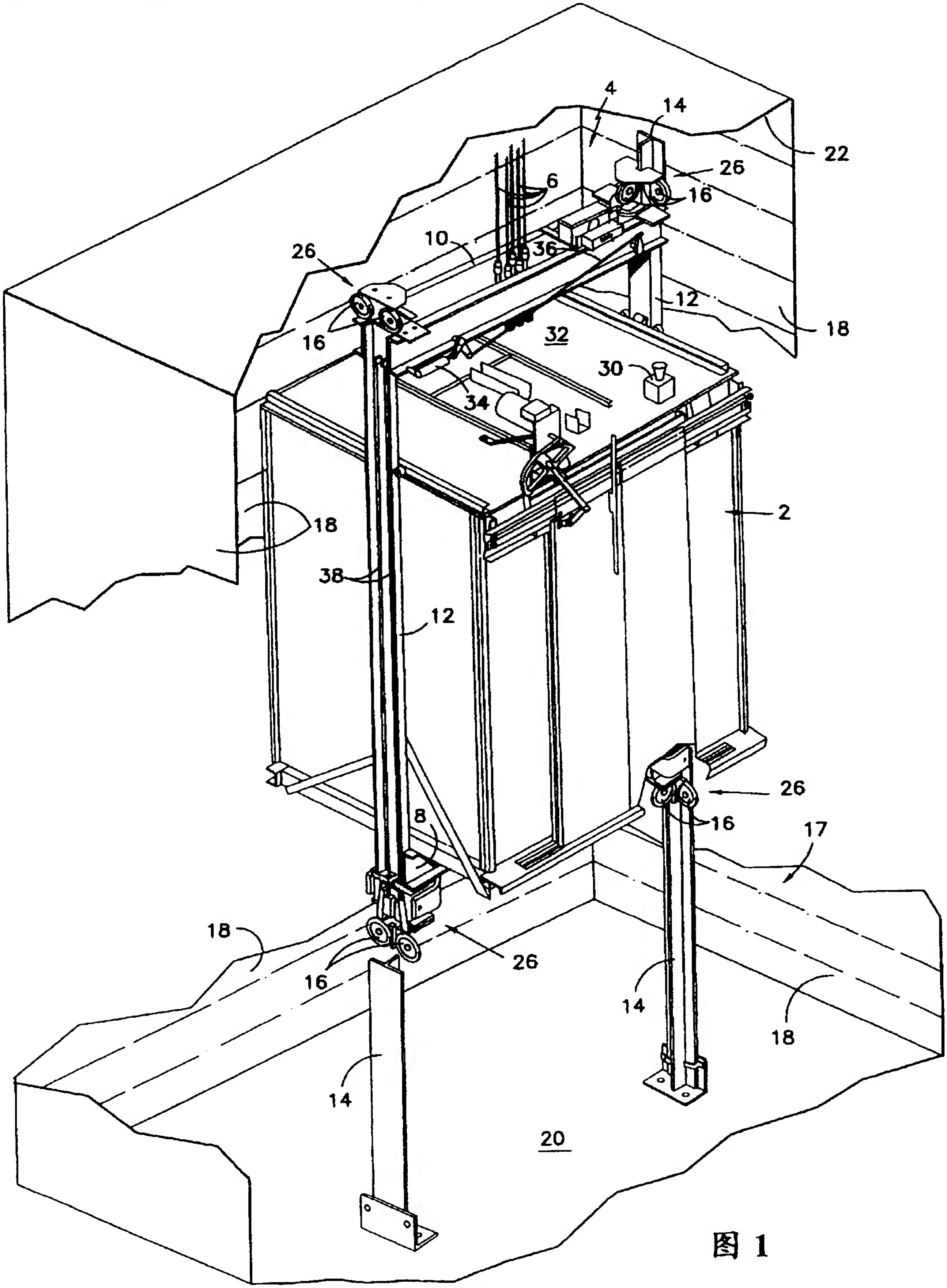
现在参照图 4, 所示的又一实施例的处理器 52 由滤波器 56、限幅器 58 和锁相环路（PLL）62 组成. 锁相环路由一电压控制振荡器和一相位检测器组成. 上述振荡器向相位检测器提供一已知的信号，输出信号 54 同样供给相位检测器. 当上述两个信号在另一信号的某一预定频率内时，振荡器频率将锁定输入频率 54. 这一技术允许实现窄带跟踪滤波器. 供给振荡器的控制电压与其频率成正比，该频率本身直接与电梯轿厢 2 的速度成正比. 初始的电压供给相应于电梯轿厢超速状态的振荡器. 当电梯轿厢 2 的速度达到超速状态时，锁相环路将锁定输入频率 54. 一种市售的芯片例如由松下公司提供的 LN565 型可用于实现上述锁相环路的功能.

处理器 52 的又一实施例表示在图 5 中，其包括一滤波器 56 和一使输出信号 54 数字化的模拟 - 数字转换器 64（A/D）. 处理器 52 还包括一数字信号处理器（DSP）66, 利用输出信号 54 的数字化型式用快速傅里叶变换来确定对应于电梯轿厢 2 的超速状态的多普勒信号.

处理器 52 产生一输出速度信号 68, 如本文所述，该信号涉及电梯轿厢 2 的速度和方向. 输出速度信号 68 被速度检测模块 70 用来用

软件、一比较器或其它等效装置检测是否存在超速状态。在本发明的一个实施例中，速度检测模块 70 包括一微处理器，该微处理器可以作为处理器 52 的一个元件、一个单独的处理器或可以包括在电梯的主处理器（未示出）中。速度检测模块 70 将速度信号与对应于超速状态的电压阈值作比较。例如，电梯可以具有 15 米/秒的额定速度，超速状态一般为额定速度的 120% +/-5%。利用上文建立的关系，当信号 68 的电压对应于大于 2773.8HZ 的阈值频率时，速度检测模块 70 输出信号 72 来触发致动器 34（图 1）和上文所述的安全制动系统的动作。

虽然已经表示和描述了优选实施例，但可对其作各种变更和替换，而不脱离本发明的精神和范围。当然，应当理解，本发明已经用示例作了说明而不是限制。


4
14
22
26
6
16
10
36
26
12
18
16
32
30
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18
2
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26
8
16
17
18
16
26
14
18
14
20

图 1

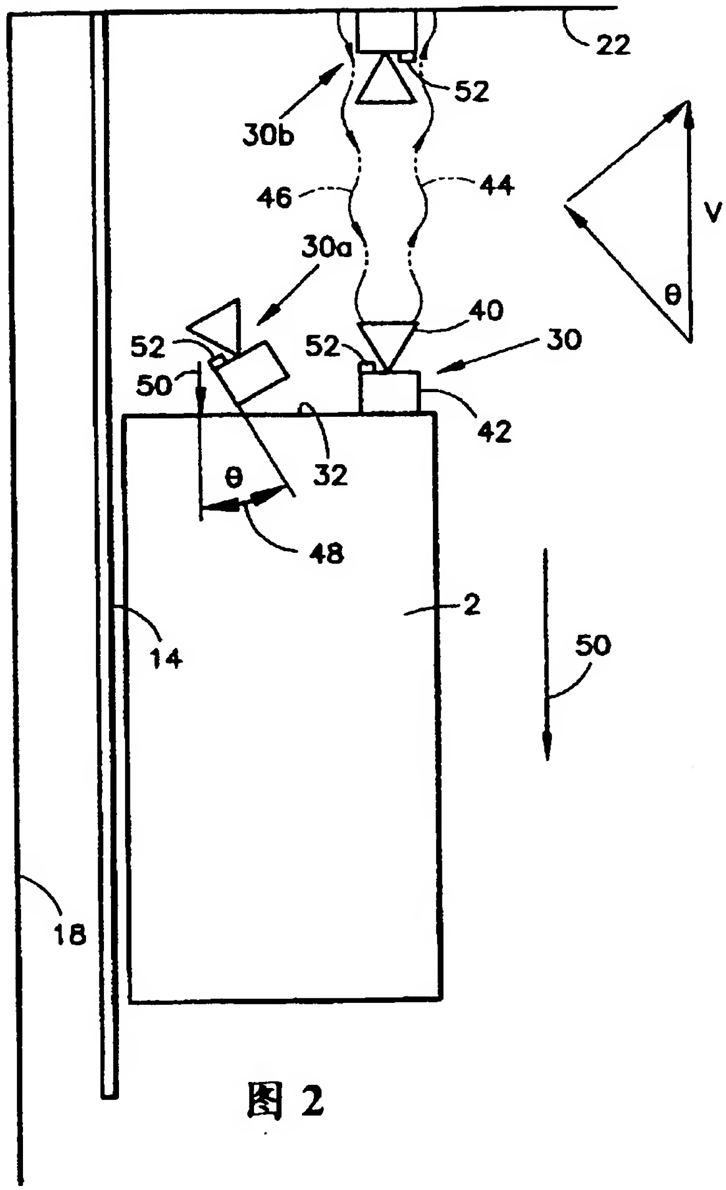

图 2

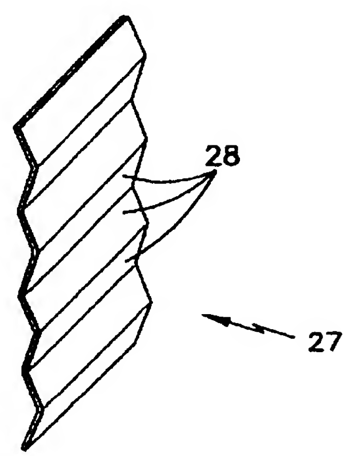

图 6

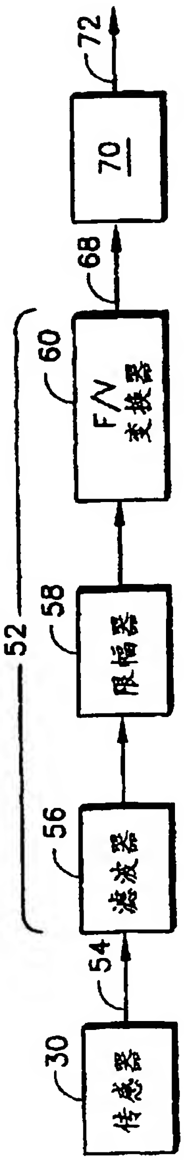
传感器
30
54
滤波器
56
限幅器
58
F/V
变换器
60
52
68
70
72

图3

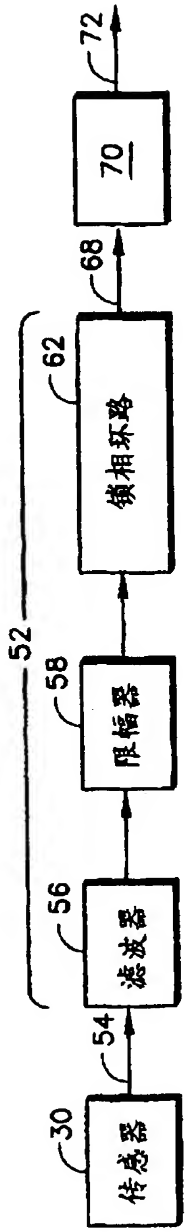
传感器
30
54
滤波器
56
限幅器
58
锁相环路
62
52
68
70
72

图4

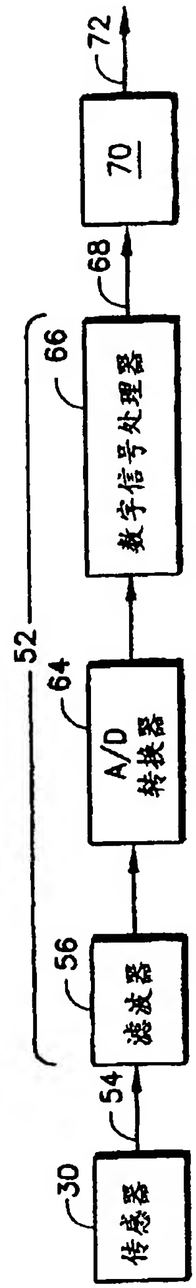
传感器
30
54
滤波器
56
A/D
转换器
64
数字信号处理器
66
52
68
70
72

图5

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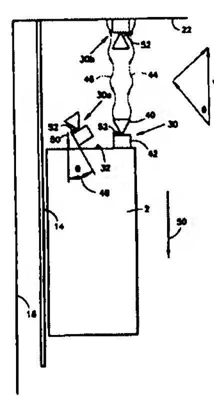
[74] Patent Agency China Patent Agency (Hong Kong)
Agents Zhao Xin Huang Lixing

Claims 2 pages Description 6 pages Attached Diagrams 3 pages

[54] Invention Name Elevator car speed detection device and method

[57] Abstract

The present invention relates to elevator car speed detection equipment and methods. It is configured with a radar speed sensor (30) for determination of the velocity of an elevator car (2). The speed sensor generates a signal that is processed by a processor (52) and compared to a speed threshold value by a speed detection module (70). The speed detection module generates an overspeed signal (72) that triggers the operation of an actuator (34) and safety brake (26).



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CLAIMS

1. An elevator speed detection system, comprising:

a speed sensor system that detects the speed of an elevator car and generates a speed signal; and

a speed detection module that compares the output signal corresponding to the speed of the elevator car that is generated.

2. The elevator speed detection system of claim 1, wherein said speed sensor system comprises:

a transmitter that directs a transmitted signal;

a receiver that receives a return signal; and

a processor that receives the return signal from the receiver and generates a speed signal.

3. The elevator speed detection system of claim 2, wherein the transmitter and receiver comprise a radar device and also include an antenna.

4. The elevator speed detection system of claim 2, wherein the processor comprises a filter, a limiter and a frequency-voltage converter or a phase-locked loop.

5. The elevator speed detection system of claim 2, wherein the processor comprises a filter, an analog-digital converter and a digital signal processor.

6. The elevator speed detection system of claim 2, wherein the transmitter and the receiver are installed on the top or the bottom of the elevator car within a hoistway.

7. The elevator speed detection system of claim 6, wherein the hoistway comprises a wall and a guide rail, the transmitted signal being directed toward the wall or the guide rail.

8. The elevator speed detection system of claim 6, wherein it also comprises a uniform structure installed on the wall or the guide rail, the transmitted signal being directed toward the aforementioned uniform structure.

9. The elevator speed detection system of claim 6, wherein the hoistway comprises a ceiling and a bottom, the transmitted signal being directed toward the ceiling or the bottom.

10. The elevator speed detection system of claim 2, wherein the elevator car is placed inside the hoistway, the transmitter and the receiver are installed within the hoistway, and the transmitted signal is directed toward the elevator car.

11. The elevator speed detection system of claim 2, wherein it also comprises a speed detection module that compares the speed signal to a speed threshold value and generates an overspeed signal that corresponds to an overspeed state.

12. An elevator system that has an elevator car and a safety braking system, said elevator system comprising:

a speed sensor system that detects the speed of the elevator car and generates a speed signal;

a speed detection module that compares the speed signal to a speed threshold value and generates an overspeed signal that corresponds to an overspeed state;

an actuator that receives the overspeed signal and triggers the safety braking system.

13. The elevator system of claim 12, wherein the speed sensor system comprises:

a transmitter that directs a transmitted signal;

a receiver that receives a return signal; and

a processor that receives the return signal from the receiver and generates the overspeed signal.

14. The elevator system of claim 13, wherein the transmitter and the receiver comprise a radar device and also comprise an antenna.

15. The elevator system of claim 13, wherein the processor comprises: a filter; a limiter; and a frequency-voltage converter or a phase-locked loop.

16. The elevator system of claim 13, wherein the processor comprises: a filter; an analog-digital converter; and a digital signal processor.

17. The elevator system of claim 13, wherein the transmitter and the receiver are installed at the top or the bottom of an elevator car inside a hoistway.

18. The elevator system of claim 17, wherein the hoistway comprises a wall and a guide rail, the transmitted signal being directed toward the wall or the guide rail.

19. The elevator system of claim 18, wherein it also comprises a uniform structure installed in the wall or the guide rail.

20. The elevator system of claim 17, wherein the hoistway comprises a ceiling and a bottom, the transmitted signal being directed toward the ceiling or the bottom.

21. The elevator system of claim 13, wherein the elevator car is placed inside a hoistway, the transmitter and the receiver are installed inside the hoistway, and the transmitted signal is directed toward the elevator car.

22. A method for detection of an elevator car overspeed state, comprising:

detection of the speed of the elevator car;

generation of a speed signal;

comparison of the speed signal to a speed threshold value;

generation of an overspeed signal.

23. The method for detection of claim 22, wherein the elevator car has a top and a bottom and is placed inside a hoistway that has a ceiling, a bottom, walls and guide rails, the aforementioned detection comprising:

direction of the transmitted signal toward the ceiling, the bottom, the wall, the guide rail, the top or the bottom; and

reception of a return signal.

DESCRIPTION

Elevator car speed detection device and method

The present invention relates to an elevator speed detection and monitoring device and method. More specifically stated, the present invention relates to a device and method used to detect an overspeed state of an elevator car and to provide a corresponding electrical signal.

Currently, elevators are configured with several braking devices that have been designed for use in normal operation of an elevator, for example, keeping it in place when it stops at a landing, and they have been designed for use in emergency states, for example stopping the elevator car from moving in a free fall.

The configuration of this type of braking device is used to cause an overspeed elevator car that is moving in excess of a predetermined rate to slow. This type of braking device usually applies a governor device that triggers the operation of safety devices. A governor rope is configured in this type of elevator system, it is wound around a pulley at the top of the hoistway and a tensioning pulley at the bottom of the hoistway, and is affixed to the elevator car. When the governor rope exceeds the predetermined rate of the elevator car, the governor device grabs the governor rope and pulls tight two rods connected to the car. These two rods pull wedge-shaped safeties, the latter pinch the guide rail on which the elevator car moves, thereby braking and causing the elevator car to slow.

The devices and methods used to detect overspeed of an elevator car are very important to the correct working of a safety braking system. In traditional systems, overspeed of an elevator car can be monitored through a governor rope, governor pulley, tensioning pulley or the linkage rods that operate mechanical safety devices. For example, the aforementioned governor pulley utilizes a centrifugal device, and when an overspeed state is reached, the latter engages a brake and generates a resisting force on the governor rope, thereby triggering the safety device. The governor rope causes the governor pulley to rotate based on the speed of rotation associated with the linear velocity of the elevator car. The governor has centrifugal counterweights that move outward as the speed is increased and as a result the centrifugal force is increased. When the elevator exceeds a predetermined speed, the centrifugal counterweights trip an overspeed switch and the latter causes a group of jaws to grasp the rope and cause the safeties to operate. In other systems, a tachometer is installed on an auxiliary rope affixed onto the pulley and is used to monitor the overspeed state of the elevator car and cause the safeties to operate.

A shortcoming of existing systems is that the rope and the governor system may experience wear. The biggest problem with this type of wear is that it cannot be detected with the naked eye. Moreover, when an overspeed state occurs, the elevator must be taken out of service until an organization [sic] is used to reset the governor device and release the safeties.

Another shortcoming of the governor rope assembly is that it must be maintained and requires hoistway space. The governor rope, pulleys and connecting rods must be regularly cleaned, lubricated and replaced. All of the maintenance requirements are bothersome as far as technical personnel in this field are

concerned and thus are unwanted properties. This requires elimination of the governor rope assembly, and it requires precision devices and methods for monitoring and detecting an overspeed state of the elevator car without requiring a governor rope assembly. Based on this need, there must also be a precise, non-contact, continuous and instantaneous device and method for detecting elevator overspeed states.

For this reason, one object of the present invention is to provide an improved method and device for detection of elevator overspeed states.

Based on the present invention, an overspeed state of an elevator is detected using a radar sensor to verify the speed of the elevator. The speed sensor continuously monitors the speed and direction of the elevator in a precise, non-contact and instantaneous manner and does not utilize the existing technology of a rope governor system. In an embodiment of the present invention, the speed sensor is installed on the elevator car and directs the transmitted signal toward one portion of the hoistway or the guide rail. In another embodiment, the speed sensor is installed on the ceiling or the bottom of the hoistway and directs the transmitted signal toward the elevator car. The speed sensor receives the return signal and generates a speed signal that indicates the speed and direction of the elevator car. The speed signal is received by a microprocessor and the latter compares said speed signal to the threshold value that corresponds to an overspeed state. When an overspeed state exists, the microprocessor generates an overspeed signal and can cause the safety brake to slow the elevator.

On the basis of the following detailed description of the present invention, the aforementioned and other objects, characteristics and advantages of the present invention are clarified further; shown in the attached diagrams are:

Figure 1 shows a partial cross-sectional drawing of the elevator in a hoistway that utilizes the sensor of the present invention;

Figure 2 shows an explanatory side view drawing of the elevator that utilizes the speed sensor of the present invention;

Figure 3 shows an explanatory drawing of the speed sensor and the processor based on the present invention;

Figure 4 shows an explanatory drawing of another embodiment of the speed sensor and the processor based on the present invention;

Figure 5 shows an explanatory drawing of yet another embodiment of the speed sensor and the processor based on the present invention;

Figure 6 shows a perspective drawing of a section of the structural strip based on the present invention.

Figure 1 shows the elevator car 2 of the present invention located on frame 4, said frame being suspended by ropes 6 and being moved by them. The elevator frame 4 comprises a safety board 8 on which the elevator car 2 sits, two vertical columns 12 on either side of the car frame 4, and a cross member 10 that is directly affixed to the elevator ropes 6. There are guide rails 14 on each side of the car frame 4, the car frame 4 slides within rollers 16 on the guide rails 14. The elevator car 2 moves vertically by means of an electric motor (not shown) within the hoistway delineated by the walls 18, bottom 20 and ceiling 22.

The elevator car 2 of the present invention does not utilize the governor rope assembly of existing technology to trigger the safety braking system when an overspeed state occurs. Based on the present invention, a radar speed sensor 30 is installed on the top surface 32 of the elevator car 2 and projects toward the ceiling 22 of the hoistway 17. As will also be more comprehensively explained in the text below, the radar sensor 30 continuously emits electromagnetic signals, and these signals are reflected by the ceiling 22. The sensor 30 continuously detects the return signals. Said sensor comprises a radio transceiver, said transceiver along with processing devices calculating the speed and direction of the movement of the elevator car 2. When an overspeed occurs, the sensor 30 emits an output signal and said signal is ultimately used to trigger a safety braking system. In the embodiment illustrated in Figure 1, the output signal triggers the actuator 34 and by means of a system of connecting rods 36 and transmission rods 38 located on each side of the elevator car 2 the safety brakes 26 apply a braking force onto the guide rails 14. The actuator 34 can comprise an air cylinder, a hydraulic cylinder, an electric motor, an electric brake or an equivalent device that can translate the connecting rod system 36. The speed sensor 30 when detecting an overspeed state of the car 2 in the two directions of moving upward and moving downward permits activation of the safety braking system, and with this, a group of safety braking systems installed on the top of the elevator car 2 stop the car in the downward direction, and a group of safety brakes 26 are installed at the bottom of the car to stop the car in the upward direction.

Refer to Figure 2 below showing three different embodiments of the present invention. In the first embodiment, the speed sensor 30 is installed on the top of the elevator car 2 and is composed of a radar oscillator transceiver such as a Doppler radar or similar article, said transceiver comprising an antenna 40 and an oscillator receiver 42 connected to it. As illustrated in the drawing, the antenna 40 is a horn-type antenna, or it may also comprise a planar antenna array, or a junction plate, antenna or other similar antenna. The oscillator receiver 42 can comprise an oscillator receiver similar to those sold on the market such as a Model MA 86849-M01 or MA86843-M05 supplied by the M/A Corporation connected to the antenna 40. The use of a dual-channel oscillator receiver permits measurement of the speed and direction of the moving elevator car 2 that facilitates overspeed control along the upward direction and the downward direction. Although the speed sensor 30 shown is an integrated-type Doppler radar device, it serves as an example and is not a restriction. Of course, the speed sensor 30 can comprise an independent transmitter, antenna, receiver and similar devices, all of which fall within the scope of the present patent. Moreover, it is also within the scope of the present patent that the speed sensor 30 can comprise other similar types of radar, for example, VORAD ETV-200 sensors manufactured by the Eaton Corporation, non-reflecting radar and transponder devices.

As described above, the speed sensor 30 is a radar device and it continually emits the electromagnetic signals illustrated as 44 via the antenna 40. The transmitted signals 44 are reflected by the ceiling 22, and the return signals illustrated as 46 are received by the antenna 40. The reflected signals 46 carry information on the speed of the car 2 relative to the reflective surface (ceiling 22).

In the second embodiment illustrated in Figure 2, the speed sensor 30a is mounted obliquely on the elevator car 2 at an angle θ illustrated with 48 relative to the velocity vector of the elevator car 2 illustrated with 50. The speed sensor 30a is positioned so that the continuously transmitted magnetic signals go toward the guide rail 14 or the wall 18 and are reflected by them. Similar to speed sensor 30, the speed sensor 30b is installed on the ceiling 22 and continuously transmits magnetic signals toward the elevator car 2 that are also reflected by it. Additionally, within the scope of the present invention, the speed sensor 30 can be installed on the floor of the elevator car 2 so that the continuously transmitted magnetic signals go toward the bottom 20 of the hoistway 17, the guide rails 14 or the wall 18 and are reflected by them. Moreover, the sensor 30 can be installed on the bottom 20 of the hoistway 17 to continually transmit magnetic signals toward the bottom of the car that are reflected by it.

Once the return signal 46 is received by the sensor 30 the oscillator transceiver 42 outputs the speed signals f_{out} illustrated using 68 in Figures 3, 4 and 5, said signals comprising a frequency that is proportional to the speed V_{ca} of the elevator car 2 based on the following formula:

$$f_{out} = COS(\theta)*2*V_{car}*f_{rad}/V_{Light}$$

In which: V_{Light} = the speed of light = 3×10^8 meters/second

f_{rad} = radio frequency = 24.125 GHz

θ = included angle 48 between the sensor axis line and the velocity vector.

The above formula is simplified as

$$f_{out} = 160.8*V_{ca}*COS(\theta)$$

The angle θ of speed sensors 30 and 30b is 0.0, said angle causing the scaling factor of the oscillator transceiver 42 output signals to be equal to 160.8 Hz/(m/s). The scaling system [sic] of the speed sensor 30a is determined by the value of the installation angle 48.

The return signals 46 contain several unwanted frequencies that are considered to be scatter and noise as well as the Doppler maximum frequency, and the average value of these frequencies corresponds to the speed of the elevator car 2. Several unwanted frequencies are emitted when the signals 44 from the antenna 40 diverge (called the viewing angle) and are the result produced by the emitted signal 44 diverging. The aforementioned viewing angle causes a corresponding divergence of the frequencies in the return signal 46. The other unwanted frequencies in the transmitted signal 44 may be caused by vibration of the installed speed sensor 30 or be the result of interruption of the signal by an obstruction, and the aforementioned signal is also converted into unwanted frequencies in the return signal 46. Moreover, a small portion of the emitted signal 44 is received directly by the antenna 40 prior to reflection and together with variations in the reflective surfaces (22, 14 or 18) may cause noise or other unwanted signals in the return signal 46.

The output signal of the oscillator receiver 42 illustrated with 54 (Figures 3, 4 and 5) is based on the return signal 46 and processed by the processor 52 connected to the oscillator receiver 42. The output signal 54 is composed of a broadened spectral line of overlapping frequencies as described above in regard to the return signal 46. Among the frequencies in the signal 54 there is a direct current bias voltage and an alternating current (AC) that carries information regarding the speed of the elevator car 2 as well as noise

and various other frequencies. The processor 52 blocks the direct current portion of the output signal and is also used to determine the average frequency of the output signal 54 that concerns the speed of the elevator car 2. A modified embodiment of the present invention is illustrated in Figure 6, wherein the structural strip 27 is placed on the guide rail 14 or the wall 18 and is used in conjunction with the speed sensor 30a (Figure 2). The structural strip 27 comprises a uniform configuration that serves as a protruding portion 28 that is illustrated by way of example as simple lines. The structural strip 27 generates the return signal 46 that has an increased amount of backward reflection, thereby increasing the reflection and improving the working precision of the present invention. The structural strip 27 can be mounted onto the guide rail 14 or the wall 18 using any suitable method. In another modified embodiment, the uniform configuration of the protruding portion can be embossed directly onto the guide rail 14 or directly processed onto the wall 18 during the manufacturing process.

Referring now to Figure 3, the illustration shows an embodiment of a processor suitable for use together with the speed sensor 30. Processor 52 is composed of a low-pass filter 56 that eliminates high-frequency noise and a limiter 58 that stabilizes the output signal 54 amplitude. The frequency of the output signal 54 is estimated using a frequency-voltage converter 60 sold on the market such as an LM2907 or 10LM2917 supplied by the Panasonic Semiconductor Company.

Referring now to Figure 4, the processor 52 of another embodiment shown is composed of a filter 56, a limiter 58 and a phase-locked loop (PLL) 62. The phase-locked loop is composed of a voltage-controlled oscillator and a phase detector. The aforementioned oscillator supplies a known signal to the phase detector and the output signal 54 is similarly supplied to the phase detector. When the two above-described signals are within a certain predetermined frequency of the other signal, the oscillator frequency will lock onto the input frequency 54. This technology enables the achievement of a narrowband tracking filter. The control voltage supplied to the oscillator is proportional to its frequency, and this frequency is itself directly proportional to the speed of the elevator car 2. An initial voltage that corresponds to an overspeed state of the elevator car is supplied to the oscillator. When the speed of the elevator car 2 reaches an overspeed state, the phase-locked loop will lock to the input frequency 54. A chip sold on the market such as the Model LN565 supplied by the Panasonic Corporation can be used to perform the aforementioned phase-locked loop function.

In another embodiment of the processor 52 illustrated in Figure 5, it comprises a filter 56 and an analog-digital converter 64 (A/D) that digitizes the output signal 54. The processor 52 also comprises a digital signal processor (DSP) 66 that uses the digitized form of the output signal 54 to use a Fast Fourier Transform for determination of the Doppler signal that corresponds to an overspeed state of the elevator car 2.

The processor 52 generates an output speed signal 68, as described previously, and this signal relates to the speed and direction of the elevator car 2. The output speed signal 68 is used by the speed detection module 70 using software, a comparator or other equivalent device to determine whether or not an overspeed state exists. In one embodiment of the present invention, the speed detection module 70 comprises a microprocessor, and said microprocessor can serve as an element or an independent processor of the processor 52 or it can be included in the main processor (not illustrated) of the elevator. The speed

detection module 70 compares the speed signal to the voltage threshold that corresponds to an overspeed state. For example, the elevator may have a rated speed of 15 meters/second, and an overspeed state is generally 120% +/-5% of the rated speed. Using the relationship established above, when the voltage of the signal 68 corresponds to a threshold frequency greater than 2773.8 Hz, the output signal 72 of the speed detection module 70 triggers the operation of the actuator 34 (Figure 1) and the aforementioned safety braking system.

Although preferred embodiments have been illustrated and described, various other modifications and substitutions may be made to them without departing from the spirit and the scope of the present invention. Of course, it should be understood that the present invention has been described using illustrations and not limitations.

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DIAGRAMS ATTACHED TO THE DESCRIPTION

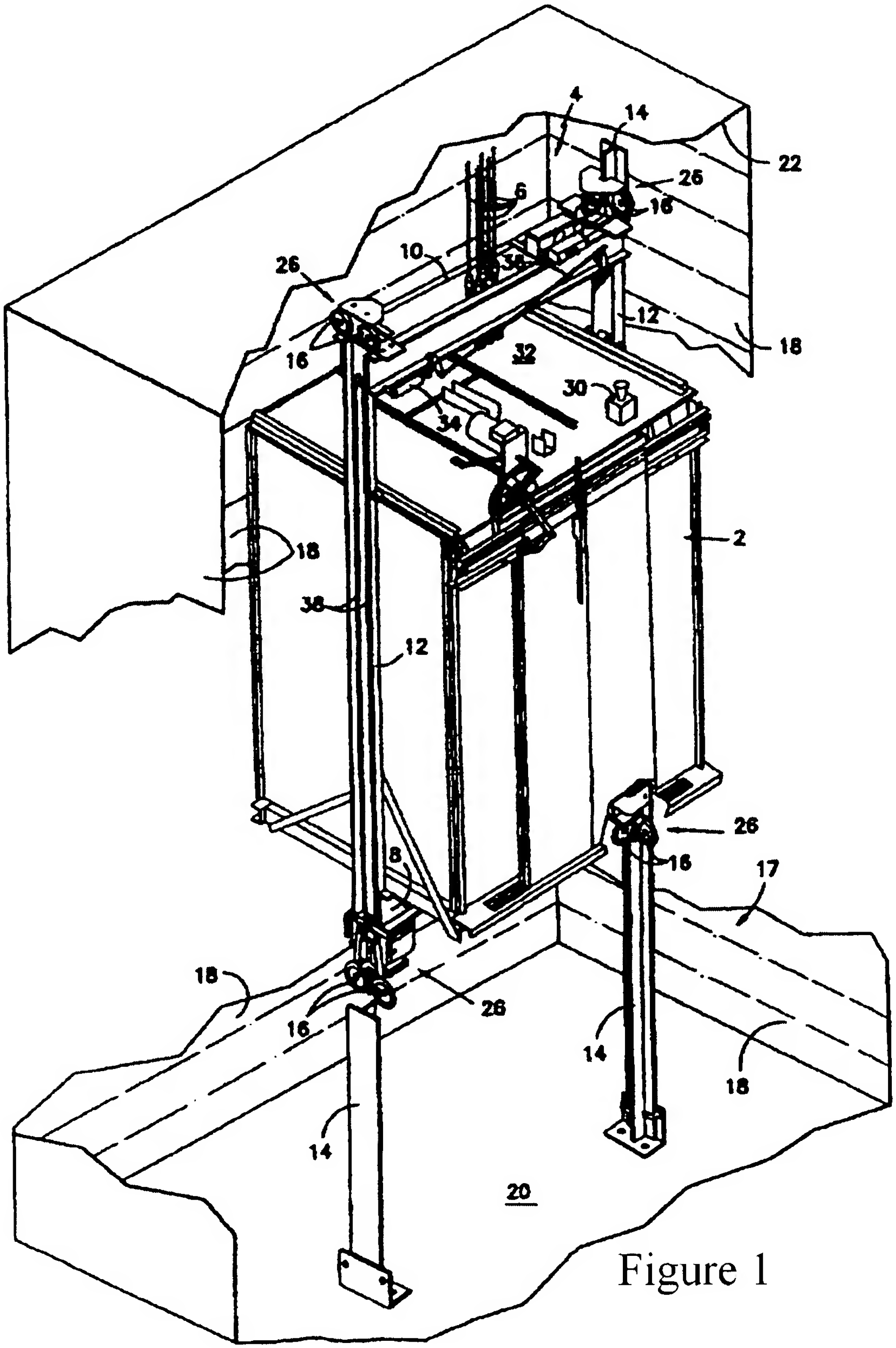

Figure 1

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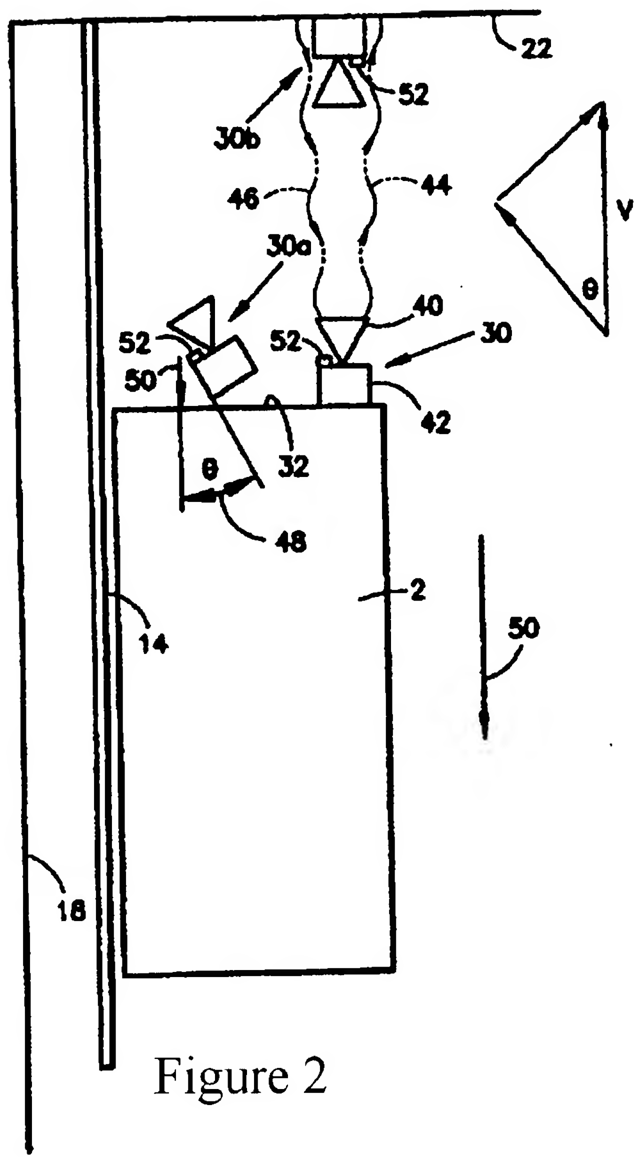
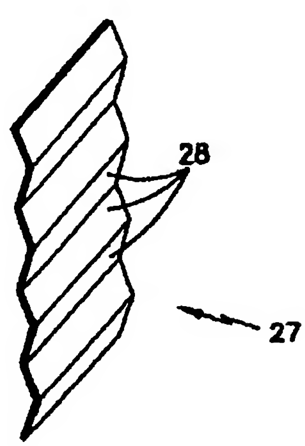


Figure 2

Figure 6



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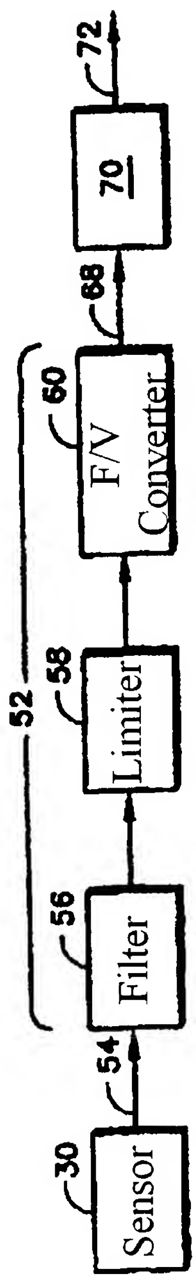

Figure 3

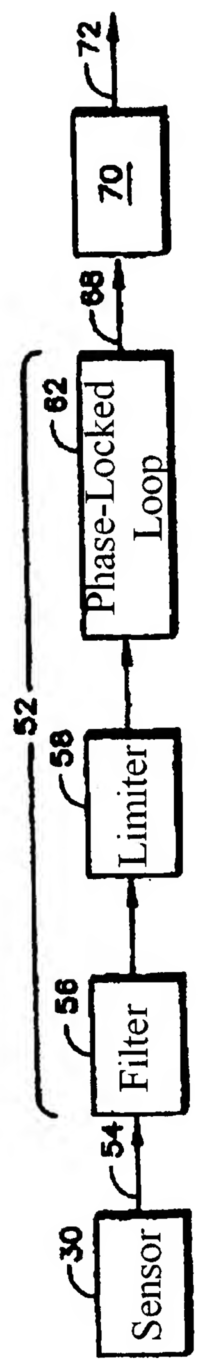

Figure 4

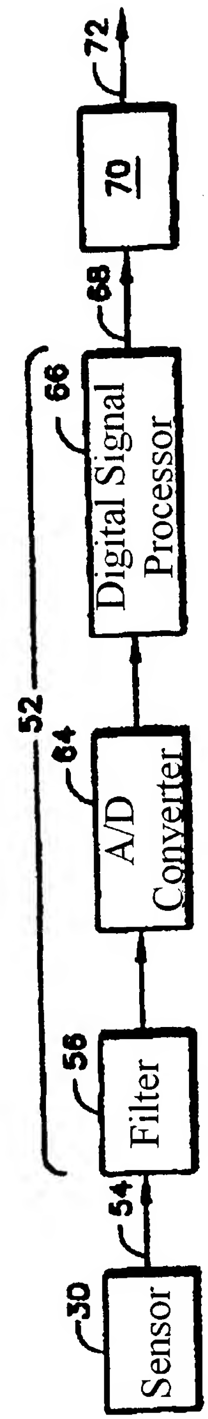

Figure 5